Institut für Volkswirtschaftslehre

Universität Augsburg

Volkswirtschaftliche Diskussionsreihe

Public Expenditures, Innovation and Economic Growth: Empirical Evidence from G20 Countries

Horst Hanusch, Lekha Chakraborty, Swati Khurana

Beitrag Nr. 329, November 2016

Public Expenditures, Innovation and Economic Growth: Empirical Evidence from G20 Countries

Horst Hanusch
University of Augsburg, Augsburg

Lekha Chakraborty
National Institute of Public Finance and Policy, New Delhi
Levy Economics Institute of Bard College, New York

Swati Khurana
National Institute of Public Finance and Policy, New Delhi

Abstract

The paper examines public expenditures and their effects on economic growth. For that purpose we choose four categories of expenditures, defence, infrastructure, human capital and R & D expenditures. Behind these expenditures stands, in socio-political consideration, a certain notion of the state as an active provider of public services for different purposes. From an analytical perspective the state is integrated in an institutional or sectoral framework which consists of the public, the financial and the real sector. All of these parts are oriented towards the development of an economy like it is formulated in the concept of "Comprehensive Neo-Schumpeterian Economics" (CNSE).

In such a framework the state offers in the first case via defence expenditures national security as a pure public good which may have severe effects on the economic situation of an economy. In the second case the state provides capital investment as a prerequisite for economic development. In the third instance the state is defined as an institution preparing individuals and society for the uncertainties to come (resilience). The fourth category is closely related to innovation, hence traditionally R & D expenditures are taken as a proxy for the propensity of a firm or a society to invest into the future by creating novelties and using them as innovations.

So, which kind of state is the most relevant one when we focus on economic growth and development? Is it the "security state" or the "development state", in the sense of catching up, which matters most? What role plays a state which focusses on resilience by stressing education and health (human capital) of its citizens in order to master the future? Or is it, last but not least, the "innovation oriented state", focussing on R & D, which has the biggest influence on economic growth?

To answer these questions we investigate the links between the four categories of public expenditures and economic growth in an empirical panel data regression model using data for the G20 countries during the period between 2000 and 2012 within the constraints of data availability. The results reveal that the impact of innovation oriented spending on economic growth is much higher than that of the variables.

The data used stems from the electronic data base of Government Finance Statistics (IMF), the Infrastructure Reports for the G20 countries and the World Development Indicators (World Bank).

Key Words: Public Expenditure, Innovation, Growth, Neo-Schumpeterian Economics
JEL codes: O30, O38, H5

Public Expenditures, Innovation and Economic Growth:
Empirical Evidence from G20 Countries*

Introduction

The effectiveness of innovation on economic growth or development is an elusive area of research, particularly in the context of G20 countries. Hanusch (2010) and Hanusch and Pyka (2007a and 2007b), are among the scarce studies which have developed an analytical framework called “Comprehensive Neo-Schumpeterian Economics” (CNSE) which allows to look empirically at the channels of innovation on economic development. Applying indicator and cluster analysis their studies detected certain patterns of future orientation for countries in different regions of the world.

The CNSE approach is based on a three pillar concept integrating the institutional domains of economic, political and financial conduct. While earlier research has emphasized on the financial and industrial linkages, this paper is stressing the public sector focussing on four of its activities, namely spending for defence, infrastructure, human capital (education and health) and R & D.

Behind these expenditures stands, in socio-political consideration, a certain notion of the state as an active provider of public services for certain purposes. From an analytical perspective the state is integrated in an institutional or sectoral framework which consists of the public, the financial and the real sector. All of them are oriented towards the development of an economy like it is formulated in the concept of CNSE.

---

* This paper was presented at the conference of the International Institute of Public Finance titled “Entrepreneurship, Innovation and Public Policy” at Lake Tahoe, August 9-11, 2016.
We want to thank Michael Stimmelmayr (ETH Zurich) for his stimulating comments.

In such a framework the state offers in the first case via defence expenditures national security as a pure public good. In the second case the state provides capital investment (infrastructure) as a prerequisite for economic development. In the third instance the state is defined as an institution preparing individuals and society for the uncertainties to come (resilience) via education and health expenditures. The fourth category is closely related to innovation, hence traditionally R & D expenditures are taken as a proxy for the propensity of a firm or a society to invest into the future by creating novelties and using them as innovations.

So, which kind of state is the most relevant one when we focus on economic growth and development? Is it the "security state" or the "development state", in the sense of catching up, which matters most? What role plays a state which focusses on resilience by stressing education and health (human capital) of its citizens in order to master the future? Or is it, last but not least, the "innovation oriented state", focussing on R & D, which has the biggest influence on economic growth?

To answer these questions we investigate the links between the four categories of public expenditures and economic growth in an empirical model using data for the G20 countries during the period between 2000 and 2012 within the constraints of data availability.

The group of G20 countries is an economic, financial and political forum which consists of 19 major economies, advanced and developing ones, allocated in Asia, Europe, Euro-Asia, North and South America, The Middle East and Oceanics. If you add the European Union you get the G20 group, which is the main economic council of wealthy nations nowadays. The 19 member countries of the G20 group together account for about 77% of world GDP, 60% of world trade and 62% of the world population (Vestergaard, 2011).

What we do in our study is to disintegrate the EU as a member of the G20 group into its single member states. So, all in all our sample conveys not only 19 but 43 countries.

The data used stems from the electronic data base of Government Finance Statistics (IMF), the Infrastructure Reports for the G20 countries and the World Development Indicators (World Bank).

Within a panel data model we tested the data for the G20 countries revealing the following outcome: The results hold good when we controlled for defence and human capital spending and turned insignificant in the case of infrastructure. Especially public expenditures related to innovation have been found significantly effective on the development process of the G20 countries.

The paper is structured as follows. Section 1 gives an overview of the existing literature dealing with the links between innovation and economic growth and identifying the gaps in the empirical literature.
Section 2 shortly describes the analytical framework of "Comprehensive Neo-Schumpeterian Economics". Section 3 interprets as an example the data for R & D or the innovation oriented activities of the state in different countries. Section 4 deals with the panel data model and its specification and interprets the results. Section 5 concludes.

I. Review of Literature and Gaps in Research

Endogenous growth models, pioneered by Romer (1986) and Lucas (1988), tried to analyse the productivity growth effects through the formation of human capital and research and development (R&D). In public finance, since the pioneering paper of Barro (1990), which established a correlation between public expenditure and economic growth, a wide empirical literature has explored this question using time series and panel estimations. Barro (1991) empirically analysed the link between public spending and economic growth in a cross-country framework of 98 countries for a period 1960-1985. Barro and Sala-i-Martin (1995). Sturm, et al. (1998) have highlighted that the marginal product of public capital is much higher than that of private capital.

Nelson and Winter (1982) analysed that innovation has public-goods property and innovation activities have significantly positive externalities, which means that public expenditure on innovation is critical to economic growth. Delong and Summers (1991) and Nadiri (1993) also found that the rate of social return from public spending on innovation exceeds the rate of private return.

In recent years, innovation has also an important place in various empirical studies conducted at both regional and national levels related to economic growth (Teixeira and Fortuna, 2004;

Canton, et. al, 2005; Batabyal and Nijkamp, 2013; Akinwale, et. al, 2012; Vogel, 2012; Jean, 2012; Cinnirella and Streb, 2013). These studies mostly emphasize that innovation, frequently arising from R&D activities, is the main engine of a growing economy, while a productivity-based positive relationship between human capital and economic growth in the investigated countries is stated.

Also Canton, et al. (2005) argue that economic growth of nations is determined by economic and technological factors such as R&D intensity and innovations as well as by human behaviour such as educational attainment. First, human capital can enhance total factor productivity directly as skilled labour. Second, it might induce technological activities of firms by innovations, imitations or adoption of new technologies (Romer, 1990; Benhabib and Spiegel, 1994; Teixeira and Fortuna, 2004; Cinnirella and Streb, 2013). Aghion and Howitt (1992) showed in their Schumpeterian endogenous growth model that R&D activities can lead to innovation as a prerequisite for technological progress which will determine economic growth in a Schumpeterian creative destruction process. Furtheron, Fagerberg (2004) demonstrates in his Schumpeterian analysis that innovation becomes a vital component for long term economic growth.

There exists also a considerable empirical literature on the effects of innovation on total factor productivity. For instance, Vogel (2012) examined the effects of R&D and human capital on total factor productivity growth. The empirical results provide significant evidence of a positive direct effect of human capital and a positive indirect effect of R&D activity on total factor productivity growth for the EU-15 regions. Jean (2012) showed that the impact of R&D and human capital are positive on regional growth in France, while Teixeira and Fortuna (2004) estimated a long run relationship between total factor productivity, in the context of the Portuguese economy. Their results showed that human capital stock is more important than internal innovation capability to explain the productivity.

The literature reviewed illustrates a huge academic interest in the topic of innovation and economic growth, especially in the aftermath of the new or endogenous growth theory. What is missing, however, is a clear cut institutional approach which would attach the sources of innovation and growth to the main players in the process of development, namely the public, the financial and the real sector of an economy. This institutional diversification helps to understand not only the macro structure of an economy but also to identify the influence of each of the three sectors on growth and development.

Only a comprehensive interpretation of the functioning of an economy which includes all three institutional pillars, but separates them concerning their sphere of influence, may picture the patterns of future orientation in an economy, which takes place in the process of growth and development. An analytical concept which certainly is conceived to cope with this idea of describing an economy is the approach of “Comprehensive Neo-Schumpeterian Economics”. So, let’s have a quick look at this approach.

I. CNSE as Analytical Framework

Schumpeterian growth and development models gained their importance in literature and political practice in the last three decades or so. They can be differentiated in a traditional Schumpeterian approach (model 1), in a Neo-Schumpeterian approach (model 2) and in the Comprehensive Neo-Schumpeterian approach (model 3).

Model 1 goes back to Schumpeter’s famous book “Theory of Economic Development”, (1912) and his later published book “Capitalism, Socialism and Democracy, (1942). It reveals the role of innovations as driving force in the development process, besides risk taking entrepreneurs (Schumpeter Mark I, 1912) or corporate innovation management (Schumpeter Mark II, 1942). Technological progress is assumed as an endogenous process and growth is characterized mainly as a quantitative phenomenon.

Model 2 builds up on model 1 improved by stressing also qualitative growth factors and processes emphasizing knowledge based formal or informal networks, collaborations between firms, governments, universities and research institutions (Saviotti and Pyka, 2004). In the literature you may also find the denotations network (cluster) model, Silicon model, ecosystem model (Wallace, 2013).

Model 3 is also based on the principle of innovation as the driving force and as the engine of development. But, in addition, it stresses the notion that innovation or future orientation is penetrating all spheres of socio-economic life in developed as well as in developing countries. So, it is the institutional setting of the three pillars which characterizes and even dominates to a high degree the development process of an economy. The three pillars build together an institutional architecture in which the dynamic processes of a society take place.

There are many alternatives how the institutional setting of an economy could look like. It may be characterized by a high institutional integration of the three pillars following closely a fundamental development strategy or development plan (figure 1a). Or, it may be figured as an institutional structure, where each of the pillars has an elaborated or evolved autonomy (figure 1b).

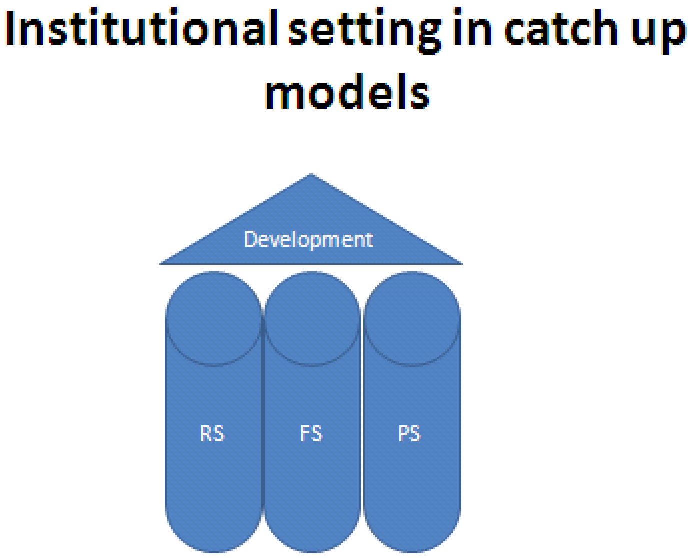


Figure 1a

Institutional setting in advanced development models

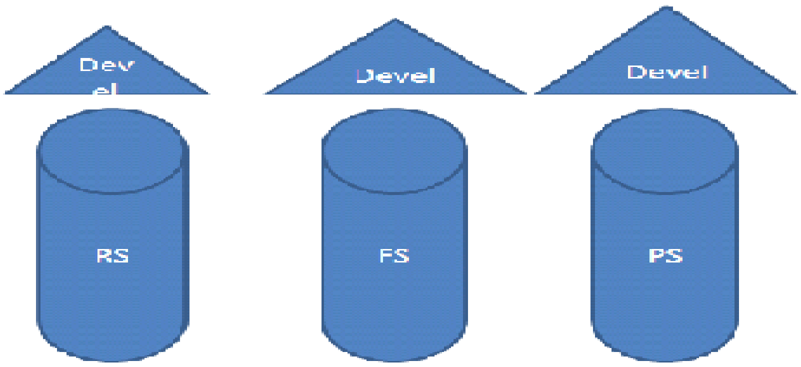


Figure 1b

The kind of institutional setting shown in figure 1a is typical for catch up models of development as they were used especially by emerging economies in Asia. The pillar closeness and the integrative development strategy gives developing countries some special opportunities. For instance, the pillars can work together very closely or even intimately to climb up the development ladder.

The institutional configuration of figure 1b isn't untypical for advanced capitalistic economies embedded in a democratic environment. Here, each of the pillars has a highly elaborated or evolved autonomy. Each one undergoes a liberalized development following a future oriented course and being part of a macroeconomic process of development as well as striving for primacy in this evolutionary process

Looking at the public sector in each of the institutional configurations government or the state has a certain political capacity or even power to influence or direct the process of development through specific budgetary means. On the expenditure side of the budget this is, above all, spending or investment in defence, education and health, infrastructure as well as science and research. This way, the public sector fulfils, more or less, the role of an "entrepreneurial state" (Mazzucato, 2013) bringing in actively his abilities to create and shape future orientation or the preparedness for future embodied in the process of growth and development.

Which kind of public activities and which notion of the state within his overall role as a political entrepreneur will have the most significant effects on this process is the key question of this paper. However, before we give an answer applying an econometric analysis, we would like to have a closer look at the empirical data used in our investigation. As an example we choose the expenditures for R & D.

II. Interpreting the Data for R & D Expenditures

The observations are analysed for 43 countries in the G20 region, by disaggregating the countries in the European Union rather than treating the EU as an aggregate member. However, data paucity has restricted us from including all the countries summarized in the EU G20 category.

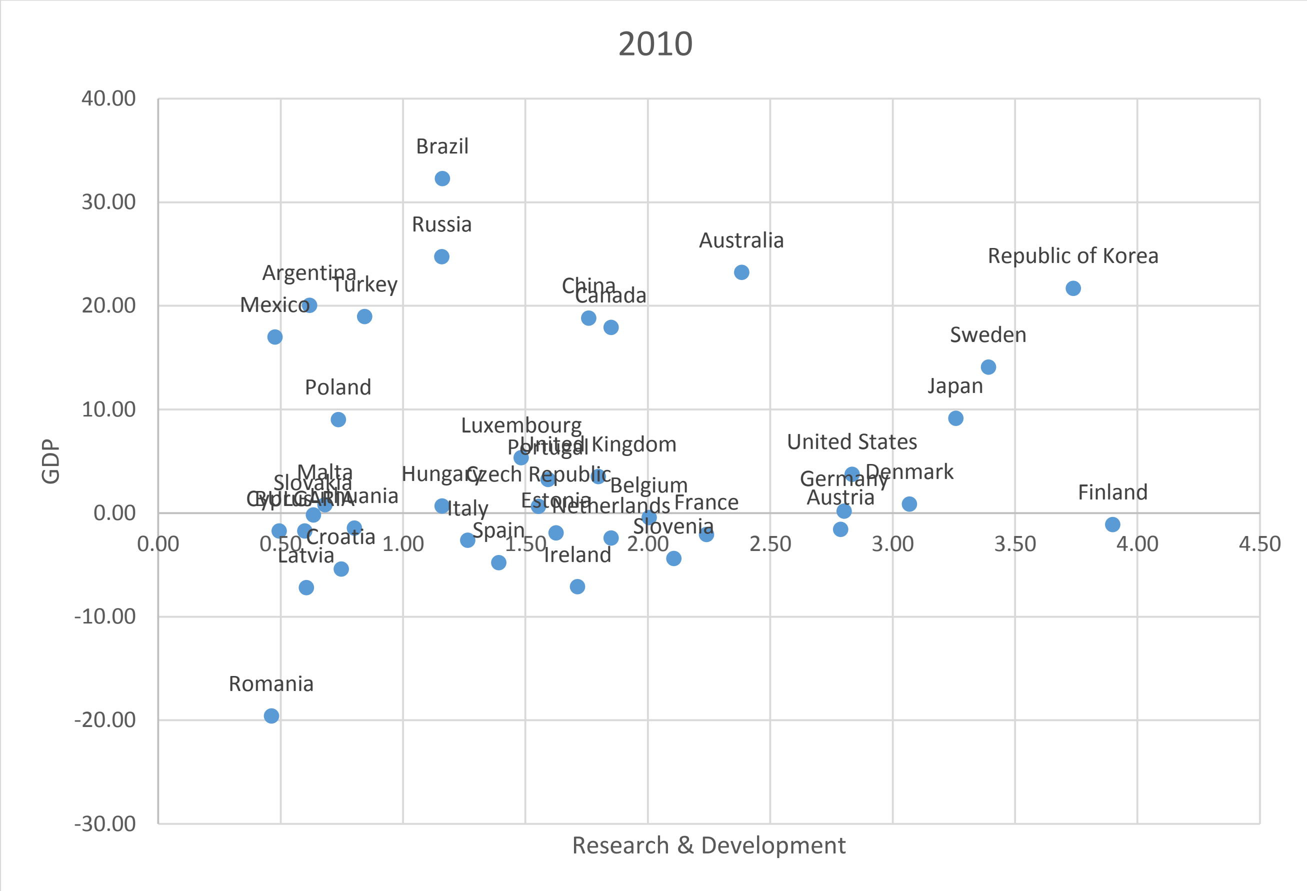
In figure 2 we only concentrate on public spending for research and development as an example to illustrate our procedure. The horizontal axis measures the level of R & D expenditures whereas the vertical axis indicates the corresponding level of GDP for the year 2000; the same bivariate scatterplot is analysed for 2005 (Figure 3) and 2010 (Figure 4). The data for R & D spending and GDP has been taken from WDI. The data for GDP is calculated in terms of current US$ and then converted into growth rates by applying the annual growth formula: $(\frac{Previous\ Value - Current\ Value}{Previous\ Value})*100$.

To give an illustrative example how the scatterplots have to be interpreted we focus only on two countries, Spain and Germany, because of limited space. This kind of data interpretation could be done also for the expenditures on defence, human capital and infrastructure as well as for all the other countries investigated. The detailed results are available on request.

For instance, the R and D expenditures for Spain increased from 0.91 per cent in 2000 to 1.12 per cent and further to 1.39 per cent in the year 2010. Whereas, the GDP growth rate went up from -6.029 per cent in 2000 to 8.25 per cent in 2005 and then plunged to -4.78 per cent in the year 2010. Analysing the graph for Germany reveals that the R & D growth rate increased from 2.47 per cent to 2.51 per cent from the year 2000 to 2005 and further to 2.80 per cent in 2010, while the GDP growth rate went up from -11.48 per cent in 2000 to 1.46 per cent in 2005 and then diminished to 0.188 per cent in the year 2010.

Looking at the intertemporal variation across the plots for the two countries also illustrates some interesting facts. The R & D expenditures for Spain increased from 0.91 per cent in 2000 to 1.12 per cent and further to 1.39 per cent in the year 2010. In the same time period the GDP growth rate developed from -6.029 per cent in 2000 to 8.25 per cent in 2005 and then fell to -4.78 per cent in the year 2010. The graph for Germany reveals that the R & D growth rate went up from 2.47 per cent to 2.51 per cent from the year 2000 to 2005 and further to 2.80 per cent in 2010. The GDP growth rate increased from -11.48 per cent in 2000 to 1.46 per cent in 2005 and then decreased to 0.188 per cent in the year 2010 (see Figure 2 for cross section plot).

Figure 2: Bivariate Plots of Innovation and Economic Growth, 2010



IV. Specifying of the Fixed Effects Models and Interpreting the Results

Before estimating the panel regressions, we have to deal with nonstationarity and heterogeneity issues in panel data models. In accordance with Levin and Lin (1992) who tested heterogeneity in unit roots against no unit roots, we tested the variables economic growth, R & D spending, education and health as well as infrastructure and defense spending for plausible unit roots, using Levin-Lin-Chu, Breitung, Im-Pesaran-Shin (IPS) and Fisher methodology. The results show that the variables have no roots. All variables are stationary (Table 1).

Table 1: Unit Root test results of economic growth, innovation, education and health spending, infrastructure and defense expenditure

ECONOMIC GROWTH

Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	-13.3915	0.0000	43	400
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-7.69124	0.0000	43	400
ADF - Fisher Chi-square	214.954	0.0000	43	400
PP - Fisher Chi-square	151.744	0.0000	43	429

INNOVATION

Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	1.41323	0.9212	41	369
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	3.21224	0.9993	41	369
ADF - Fisher Chi-square	52.5486	0.9953	41	369
PP - Fisher Chi-square	57.9927	0.9795	41	384

INFRASTRUCTURE

Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	-12.1044	0.0000	12	117
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-8.88690	0.0000	12	117
ADF - Fisher Chi-square	107.792	0.0000	12	117
PP - Fisher Chi-square	151.869	0.0000	12	120

DEFENSE

Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	-10.6932	0.0000	35	287
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-3.36500	0.0004	33	281
ADF - Fisher Chi-square	114.222	0.0007	35	287
PP - Fisher Chi-square	127.589	0.0000	35	294

EDUCATION

Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	-6.92362	0.0000	35	288
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-1.63056	0.0515	33	282
ADF - Fisher Chi-square	99.2583	0.0123	35	288

PP - Fisher Chi-square	86.7866	0.0847	35	294

HEALTH

Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	-6.39477	0.0000	35	289
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-1.14461	0.1262	33	283
ADF - Fisher Chi-square	80.9662	0.1741	35	289
PP - Fisher Chi-square	100.543	0.0098	35	293

** Probabilities for Fisher tests are computed using an asymptotic Chi

-square distribution. All other tests assume asymptotic normality.

The descriptive statistics of the macro variables show up in Table 2.

Table 2: Descriptive Statistics of the Macro Variables

	GDP growth	Education	Health	Innovation	Defense
Mean	0.775268	11.13548	8.426761	0.775268	6.117331
Median	0.740535	10.87000	10.47500	0.740535	5.250000
Maximum	1.758990	30.54000	16.87000	1.758990	12.02000
Minimum	0.047560	1.290000	0.120000	0.047560	2.480000
Std. Dev.	0.352936	5.641097	5.089101	0.352936	2.571825
Skewness	0.709701	0.218407	-0.439884	0.709701	0.826897
Kurtosis	3.131363	3.977710	1.807365	3.131363	2.542360
Jarque-Bera	5.418560	3.057932	5.856982	5.418560	7.851921
Probability	0.066585	0.216760	0.053478	0.066585	0.019723
Sum	49.61718	712.6710	539.3127	49.61718	391.5092
Sum Sq. Dev.	7.847512	2004.784	1631.634	7.847512	416.6998

Source: Authors' Computations

Now we can specify our Fixed Effects models as follows.

(i) $G = \alpha + \beta_1 def_{it} + \beta_2 inv_{it} + \mu_{it}$

(ii) $G = \alpha + \beta_1 def_{it} + \beta_2 hcap_{it} + \beta_3 inv_{it} + \mu_{it}$

(iii) $G = \alpha + \beta_1 def_{it} + \beta_2 hcap_{it} + \beta_3 infra_{it} + \beta_4 inv_{it} + \mu_{it}$

G represents GDP growth rate,

def represents growth rate of Defense Expenditure,

hcap represents growth rate of Human Capital (Education and Health) and

inv represents Research and Development Expenditure as a percentage of GDP.

Infra includes expenditure on Energy, Telecom, Water & Sanitation and Transport.

Here,"i" stands for a particular country and "t" for a particular year.

To analyse the link between the different categories of public spending and economic growth we used all three Fixed Effects models. While model 1 incorporates fiscal spending on defense as control variable, models 2 and 3 sequentially control for human capital and infrastructure spending variables. All variables are expressed in growth rates.

We estimated the pooled regressions with cross-section weights (Pooled EGLS) for two scenarios. In scenario 1, we aggregated the spending for health and education to get the growth rates of total expenditures in this area. In scenario 2, we re-estimated the pooled regressions with cross section weights by aggregating the public spending on education and health, along with spending on innovation, infrastructure and defense.

The results show in scenario 1 that public expenditure on innovation and human capital formation (aggregate spending on health and education) matter for economic growth. However, one per cent of spending on R&D would increase economic growth by 9.57 per cent, while a one per cent rise in spending on human capital would increase economic growth by only 0.29 per cent. Public expenditures on infrastructure and defense are found insignificant in their impact on economic growth (Table 3).

The results for scenario 2 revealed that only innovation matters for growth. The coefficients showed that one per cent of increase in spending on R & D would increase the economic growth by 9.92 percentage points (Table 3).

Table 3: Results from Pooled Regressions with Cross-section Weights

Scenario 1 (Human Capital Variables are aggregated in Scenario 1)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
?E+?H	0.286775	0.081317	3.526616	0.0008
?RD	9.574599	4.685967	2.043249	0.0454
?D	0.066100	0.573216	0.115314	0.9086
?I	0.012677	0.013154	0.963685	0.3391

Weighted Statistics

R-squared	0.071435	Mean dependent var	17.82583
Adjusted R-squared	0.025007	S.D. dependent var	19.31688
S.E. of regression	16.54272	Sum squared resid	16419.70
Durbin-Watson stat	1.650090		

Unweighted Statistics

R-squared	0.069005	Mean dependent var	12.98479
Sum squared resid	17478.62	Durbin-Watson stat	1.872660

Scenario 2 (Human Capital Variables are disaggregated in Scenario 2)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
?E	0.251078	0.192126	1.306841	0.1963
?H	0.302251	0.310537	0.973319	0.3344
?RD	9.922388	4.789704	2.071608	0.0427
?D	0.032829	0.584022	0.056211	0.9554
?I	0.012788	0.013236	0.966095	0.3379

Weighted Statistics

R-squared	0.070173	Mean dependent var	17.61039
Adjusted R-squared	0.007134	S.D. dependent var	18.64051
S.E. of regression	16.69379	Sum squared resid	16442.28
Durbin-Watson stat	1.650161		

Unweighted Statistics

R-squared	0.070346	Mean dependent var	12.98479
Sum squared resid	17453.44	Durbin-Watson stat	1.878959

Source: Authors' Computations.

V. CONCLUSION AND POLICY RESULTS

In this paper we examine the relationship between public spending oriented towards innovation – measured by R & D expenditures as a proxy variable - and economic growth for the G-20 countries over the period of 2000- 2010 using panel data analysis. In this analysis we included human capital (education and health), infrastructure and defense spending as control variables to analyse the impact of innovation on the GDP growth rate in a multivariate framework. The GFS (Government Finance Statistics) yearbooks have been used to compile the data for defense spending and human capital (health and education). While the data for GDP, Research and Development and Infrastructure (energy, telecom, water & sanitation and transport) has been collected from WDI (World Development Indicators).

The panel data regression results show that innovation spending has a significant impact on economic growth in the G-20 countries. The pooled regression with cross section weights also shows that the coefficient of innovation is much higher than the coefficients of the other variables. This result has a remarkable policy implication. Public expenditures for R & D (innovation) have a significant positive macroeconomic impact on economic growth. So, investment in R & D is crucial for a sustainable economic growth in the G-20 countries. This kind of GDP growth might be called as innovation driven and it is in full accordance with Schumpeterian ideas of economic development.

References

Aghion, P. and Howitt, P. (1992), A Model of Growth Through Creative Destruction, Econometrica, 60, (2), pp. 323-351.

Akinwale, et. al, (2012), “Understanding the Nexus of R&D, Innovation and Economic Growth in Nigeria”,International Business Research, 5(11), pp. 187-196.

Barro, R.J. (1990), “Government Spending in a Simple Model of Endogenous Growth,”Journal of Political Economy 98, pp. 103-125.

Barro, R.J. (1991), “Economic growth in a cross section of countries”, *The Quarterly Journal of Economics*, 106 (2), pp.407-443.

Barro, R. and Sala-i-Martin, X. (1995), Economic Growth, McGraw-Hill.

Batabyal and Nijkamp, (2013), “Human capital use, innovation, patent protection, and economic growth in multiple regions”, Economics of Innovation and New Technology, 22(2), p. 113–126.

Benhabib, J. and Spiegel, M. M. (1994), “The role of human capital in economic development Evidence from aggregate cross-country data”, *Journal of Monetary Economics*, 34, pp. 143-173.

Canton, et. al, (2005), Human Capital, R&D and Competition in Macroeconomic Analysis, WP38, ENEPRI.

Cinnirella and Streb, (2013). The Role of Human Capital and Innovation in Prussian Economic Development, WP4391, Cesifo.

DeLong J. Bradford and Lawrence H. Summers (1991), "Equipment Investment and Economic Growth," Quarterly Journal of Economics, 106 (2), pp. 445-502.

Fagerberg, J., (2004), Innovation: A guide to the Literature, in Fagerberg, J., Mowery, D., and Nelson, R (eds.) The Oxford Handbook of Innovation, Oxford University Press, Oxford, 2004, p 1-26.

Hanusch, H. and Pyka, A., (2007a), The Principles of Neo-Schumpeterian Economics, Cambridge Journal of Economics, 31(2), pp. 275-289.

Hanusch, H. and Pyka, A., (2007b), Applying a Comprehensive Neo-Schumpeterian Approach to Europe and its Lisbon Agenda, in: Tilly, R., Welfens, P. und Heise, M. (eds.), 50 years of EU Dynamics, Integration - Financial Markets and Innovations, Springer, Berlin, Heidelberg, New York, pp. 275 – 300.

Hanusch, H., Pyka, A., Wackermann, F., (2010), Patterns of Future-Orientation in Central and Eastern Europe, in: Köz-Gazdaság (Quarterly Journal, Faculty of Economics, Corvinus University Budapest), Special English Language Issue: Economic Theory and Policy, pp. 173-189.

Hanusch, H., (2010), Fighting the Crisis: Public Sector Governance in a Comprehensive Neo-Schumpeterian System, in: Bd. 72 der Schriftenreihe des "Munich Institute of Integrated Studies", Homo Oeconomicus 27(1/2), pp. 89-104.

Jean, G., (2012), Human Capital And R&D Driven Growth: Analyze for France at Regional Level on The Long Run, WP 274, Université de Franche-Comté.

Lucas, G., (1988), “On The Mechanics of Economic Development”, Journal of Monetary Economics, 22, pp. 3-42.

Mazzucato, M., (2013), The Entrepreneurial State, Debanking Private vs. Public Sector Myths in Risks and Innovation, Anthem Press, London, New York.

Nadiri, M. I., (1993), Innovations and Technological Spillovers. Working Paper, 4423, Cambridge, MA: National Bureau of Economic Research, 8.

Nelson, R. R. and Winter, S. G., (1982), The Schumpeterian Tradeoff Revised, American Economic Review, 72.

Romer, P.M., (1986), Increasing Returns and Long Run Growth. Journal of Political Economy, 94 (5), pp. 1002-1037.

Romer, P. M., (1990), “Endogenous Technological Change”, Journal of Political Economy, 98 (5): 71-102.

Saviotti, P. P. and Pyka, A., (2008), Product Variety, Competition and Economic Growth, Journal of Evolutionary Economics, 18(3-4), pp. 323-347.

Schumpeter, J. A., (1912), Theorie der Wirtschaftlichen Entwicklung, Dunker & Humblot, Leipzig.

Schumpeter, J. A., (1942), Capitalism, Socialism and Democracy. Harper & Brothers, New York

Sturm, J. E. (1998), Public Capital Expenditure in OECD Countries: The Causes and Impact of the Decline in Public Capital Spending, Aldershot and Lyme NH, Edward Elgar.

Teixeiara, A., and Fortuna, N., (2004), “Human Capital, Innovation Capability and Economic Growth”, FEP Working Paper No. 131 (July).

Vestergaard, P., (2011), G20 and Beyond: Towards Effective Global Economic Governance, DIIS Report.

Vogel, J, (2012), The Two Faces of R&D and Human Capital: Evidence from Western European Regions, WP 599, University of Oxford.

Wallace, R., (2013), A New Formal Approach to Evolutionary Processes in Socio-Economic Systems, Journal of Evolutionary Economics, 23(1), pp. 1-15.

World Bank, (1999), World Development Report 1998-1999: Knowledge for Development, Oxford University Press, New York.